RECONSTRUCTION OF THE TADOUSSAC AND BAIE-SAINTE-CATHERINE, QUEBEC, LANDING DOCKS – IMPACTS ON MARINE MAMMALS

Context

The existing ferry boats between Tadoussac and Baie-Sainte-Catherine, operating since 1980, have reached the end of their useful life. In 2013, the Société des traversiers du Québec (STQ) will replace these ferries with two new ships of greater capacity. Although slightly larger, the new ferries would be able to operate with the existing infrastructures. However, they would be affected by operational constraints, including the inability to guarantee service during high tide. Therefore, to enable optimal use of the new ferries, the STQ would like to expand one of two access ramps at each of the landing docks.

The reconstruction project of the Tadoussac and Baie-Sainte-Catherine landing docks is not subject to the *Canadian Environmental Assessment Act* (CEAA) and does not require an authorization pursuant to subsection 35(2) of the *Fisheries Act* (FA). However, the increase in underwater noise caused by drilling and sawing activities could disturb or harm marine mammals present at the mouth of the Saguenay River, particularly the St. Lawrence beluga.

To ensure that the project will not cause significant impacts to marine mammals, the Fish Habitat Management Division (FHMD) sought, on August 5th, 2011, the cooperation of scientists from the Regional Science Branch, who have expertise on marine mammals in the St. Lawrence Estuary, to obtain their advice on the potential impacts on cetaceans, particularly the St. Lawrence beluga (species at risk).

Considering the short notice (advice required August 26th, 2011 in order not to hinder the beginning of the work), a *Science Special Response Process* (SSRP) was initiated to provide scientific advice on five specific issues related to this project and its potential impacts on cetaceans:

1. Are the estimates of noise level generated by the operations and the propagation distances provided by the consultant realistic? Are the estimates provided by the consultant concerning noise reduction by the implementation of mitigation measures (containment and bubble curtain) valid and realistic?
2. Is it fair to consider that the noise impacts generated by the operations will be mitigated by the fact that the mouth of the Saguenay is a noisy environment because of the significant shipping traffic occurring there?
3. Will the project, as proposed, prevent any physical damage to belugas? If not, what additional mitigation measures would reduce the risk of physical harm? What if operations do not occur in a confined environment?
4. Is the project, as proposed, likely to cause disturbance for the beluga? If so, what additional mitigation measures would make the disturbance acceptable? What if operations do not occur in a confined environment?

5. In the event the project causes disturbance to the beluga despite the implementation of additional mitigation measures, is the anticipated disturbance likely to jeopardize the species' recovery?

This Science response report stems from the analysis conducted between August 15-18, 2011, under the SSRP on the review of potential impacts on marine mammals by the reconstruction project of the Tadoussac and Baie-Sainte-Catherine landing docks. Three experts in underwater acoustics and in marine mammal behaviour were present. A description of the main aspects of the project, timelines and proposed mitigation measures were presented for consideration in order to formulate this advice.

The proposed reconstruction project of the Tadoussac and Baie-Sainte-Catherine landing docks will occur at the heart of the beluga habitat in the St. Lawrence and Saguenay-St Lawrence Marine Park. Belugas are present there 50% of the time, at least from May to September, to feed or to transit to other frequently attended areas. Minke whales occur there frequently while other marine mammals are present more occasionally. Construction noise associated with the project will be an additional contribution to the high level of noise from the ferries and the ecotourism whale-watching fleet during the construction period, estimated at 20 months. No loud noise such as impulse noise (e.g. piling or sheet pile driving) is scheduled in the project, but noise from non-impulse drilling and other operations will be frequent. The levels and frequencies of these sounds are detectable by marine mammals and fish in the region. Although the risk of causing physical damage to the animals' internal tissues is low, the noise poses a risk to the health and recovery of the St. Lawrence beluga, a threatened species under the Species at Risk Act (SARA). The operations and mitigation measures proposed by the proponent and additional measures proposed herewith should help minimize the impacts of these operations on the beluga and other marine mammals at the mouth of the Saguenay River.

Background

Frequentation by Marine Mammals at the Mouth of the Saguenay River

The mouth of the Saguenay is at the heart of the beluga habitat in the St. Lawrence and Saguenay-St Lawrence Marine Park (SSLMP) (Caron and Sergeant, 1988; Lemieux-Lefebvre, 2009; Lesage et al., 2007; Michaud et al., 1990; Mosnier et al. 2010). Regular summer monitoring of the region by the SSLMP since 2003 shows that other marine mammals occur there as frequently such as minke whales, harbour seals, and occasionally fin whales, humpback whales, harbour porpoises, grey seals and harp seals (Conversano, unpublished data; SSLMP, unpublished data). Belugas are present 51% of the time from May to September (*ibid.*). The lack of systematic observations does not provide effective occurrence levels for the remainder of the year.

Frequentation tends to follow daily patterns, with a higher number of animals in the morning and early afternoon, and tidal patterns (tide related), with densities increasing during the rising tide (*ibid.*). Adults compose on average 76% of pods, juveniles 20% and calves 4% (*ibid.*).

This central habitat region for the St. Lawrence beluga serves as a hub for transiting pods between the frequentation areas in the lower and upper St. Lawrence Estuary and areas in the

Saguenay River Fjord upstream from the mouth, including Sainte-Marguerite Bay. Its main function seems to be primarily related to feeding, with nearly 50% of groups occurring there demonstrating surface behaviour typical for this type of activity (*ibid.*). In fact, recent observations have shown a steady research and survey behaviour for prey by belugas using their biosonar throughout the dive (Roy et al., 2010). This habitat use increases with the rising tide, while the tidal subduction of cold water from the estuary in the deep waters of the Saguenay is at its highest and concentrations of small fish during frontal processes are higher (Conversano et. al., 2009; Simard et al., 2008). Observations show significant variations in terms of seasonal and annual abundance. The seasonal pattern is not stable, with abundances increasing in August and September in 2008 and 2009, unlike previous years where a maximum was noted in June-July (Conversano, unpublished data; SSLMP, unpublished data). Events of exceptional abundance of belugas and other cetaceans occur during certain periods, as observed in September 2008 for several days (*ibid.*, Simard et al., 2010), presumably in response to specific biophysical events of transport and concentration of their prey in the area at the mouth of the Saguenay River. The average distribution of belugas at the mouth of the Saguenay is centered off the coast of Pointe-Noire and follows a pattern varying with the tide (Conversano, unpublished data; Simard et al., 2010).

Local Noise and Noise Associated with this Type of Work and its Impacts

Studies on underwater noise at the mouth of the Saguenay show that noise in this area is particularly high, that this loud noise covers a wide frequency band, and it originates from the presence of ferries and local navigation of the ecotourism whale-watching fleet, whose ports are Tadoussac and Baie-Sainte-Catherine (Gervaise et al., unpublished data, McQuinn et al. unpublished data). The average hourly broadband noise (10 Hz to 20 kHz) hovers around 120 dB re 1 μPa_{rms}, a level that is exceeded by about 2 dB at peak activity of the fleet during the day (Chion et al. 2010), and is reduced by about 4 dB for the slower ferry pace at night. During the 7.5 minutes of crossing, the instant broadband noise (1-20 kHz) associated with the ferries measured at a distance of 1.3 km from their path increases by an average of 24 dB (Gervaise et al., unpublished data).

The various construction activities associated with the proposed reconstruction project of the Tadoussac and Baie-Sainte-Catherine landing docks will generate noise that will be irradiated in the surrounding water. The frequency (spectrum) and intensity of this construction noise (e.g. e.g. Blackwell et al., 2004; Greene et al., 2008; Mann et al., 2009) allow for detection and audibility by a wide variety of organisms (see cf. Au & Hastings 2008, Popper & Hastings 2009, Slabbekoorn et al. 2010), including marine mammals that may be present in this habitat.

The mentioned construction activities do not include impulse noise, such as explosions or driving pilings or sheet piles. The noise in the water will be associated with drilling operations to anchor the seating of the new structures, levelling with a hydraulic shovel, installing pilings, formwork and reinforcements, demolition of the replaced dilapidated seating, and related activities. These sounds are essentially non-impulse noise. Their intensity is concentrated at low frequencies, from a few hundred Hz to a few kHz, but noise beyond 10+ kHz is detectable at short range (Blackwell et al., 2004; Greene et al., 2008; Mann et al., 2009). Broadband peak levels (SPL_{p-p}) or RMS (SPL_{rms}) are lower by several tens of dB compared to impulse noise from piling and sheet pile driving, with their high intensity spreading over great distances and causing the greatest impact on fish and marine mammals (Rodkin and Reyff, 2004; Madsen et al., 2006; Erbe, 2009; Hildebrand, 2009; Bailey et al., 2010; Hastings, 2011; Brandt et al., 2011). Non-

impulse noise presents fewer risks of physically harming to the exposed animals (Southall et al., 2007). Their impact on animals can be seen through physiological and behavioural impacts, such as stress, small and large spatial scale habitat displacement for varying periods, disappearance of food sources that may negatively affect the energy balance and impact survival, the masking of communication and auditory perception of the environment, etc. (Hastings and Popper, 2005; Southall et al., 2007; Popper and Hastings, 2009; Slabbekoorn et al., 2010).

Marine mammals, especially the beluga, nicknamed the sea canary, use acoustics extensively in exercising their daily life functions, such as communication, searching for and locating prey, navigation and auditory perception of the environment, anthropogenic threats, predators. The impact of acoustic interference introduced in their environment by humans, such as the proposed project, which will occur over a 20-month period, will have significant impacts on their health status (Nowacek et al. 2007, Weilgart 2007, Tyack 2008). They pose a risk to the recovery of species at risk occurring in the area, according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); such as the beluga which is threatened, and that uses the area consistently, but also the fin whale and harbour porpoise which occur occasionally in the area and whose statuses are considered of special concern.

Analysis and Response

Response to Questions:

Question 1

Are the estimates of noise level generated by the operations and the propagation distances provided by the consultant realistic? Are the estimates provided by the consultant concerning noise reduction by the implementation of mitigation measures (containment and bubble curtain) valid and realistic?

Response 1

Noise level estimates at the source provided for drilling operations (185 dB re 1 µPa @ 1 m) are higher than the observations available in the literature as cited above. They are therefore conservative. The sawing noise estimates given do not provide the metric used (SPL_{pp}, SPL_{rms}, bandwidth, spectrum level in Hz) or units (dB re 1µPa_{pp}, dB re 1µPa_{rms}, dB re 1µPa^2/Hz), or published reference to this work; therefore it is impossible to assess the value.

Estimates, from the literature, are provided for the expected reduction of noise level by the implementation of proposed mitigation measures, by confinement, sound insulation and ventilation of the noisy work area. These estimates are representative of work done elsewhere for other noise sources (pile driving). However, their associated variance is unknown, due to the quality of their implementation (important to monitor based on the reported experiments in the literature), or their transferability to other types of noise (drilling). Therefore it is not possible to know whether these noise level reductions will be achieved. However, it should be noted that the proposed mitigation measures are appropriate and consistent with the highest standards currently available in this area.

Using the simple spherical dispersion model (20 log $r + \alpha r$, where r represents the range and α the absorption coefficient) to estimate the effect of noise propagation is appropriate for the considered short range noise.

Question 2

Is it fair to consider that the noise impacts generated by the operations will be mitigated by the fact that the mouth of the Saguenay is a noisy environment because of the significant shipping traffic occurring there?

Response 2

As mentioned previously, the region at the mouth of the Saguenay River is particularly noisy due to the ferry and the activities by the fleet of ecotourism vessels. The levels of construction noise will be added to those already present, further decreasing the quality of this habitat for marine mammals occurring there. During the 7.5 min period for ferry crossing, the noise is likely to be drowned out and indistinguishable from ferry noise. This will also be the case during peak navigation of the ecotourism fleet; i.e. departures and arrivals of daily excursions. However, the opposite will occur when the ferries stop for loading and unloading and navigation at the mouth of the Saguenay is reduced. Continuous loud construction work would therefore reduce this low noise period which provides a rest from the noise, allows for physiological recovery, increase the communication range and perception of the environment for animals to perform their various functions.

As the work will take place over a long period of 20 months, including the period beyond the ecotourism season, and the animals are present over much of the year, the risk of impact on the use of this habitat in the short and medium term by the beluga and other marine mammals is noteworthy.

One way to minimize the risk of increasing the impact of anthropogenic noise in the region and to maximize the recovery time would be to restrict loud work to periods of ferry crossings. It is assumed that this would be feasible without much difficulty and that no work would be carried out overnight. However, should this not be the case, since three ferries are usually in operation during the high tourism season, periods of calm during the day are almost nonexistent. As beluga occurrence in the Saguenay River is significant in the summer (see above), and also at the mouth of the Saguenay during the same period, and likely from spring until late in fall, no-work periods should be imposed over a significant period overnight when ferry crossings are at their minimum. This measure could be seasonal and could be applied especially from spring to fall.

Question 3

Will the project, as proposed, prevent any physical damage to belugas? If not, what additional mitigation measures would reduce the risk of physical harm? What if operations do not occur in a confined environment?

Response 3

As the currently proposed project has no strong impulse noise, the risk of physical damage to internal tissues of belugas is reduced. In addition, the proposed measures to mitigate the generated noise, by confinement and air bubbles, reduce the risk even further. If the work is not carried out in a confined environment, an exclusion zone of 600 m between mid-September to mid-October, and 300 m from mid-October to April 30 will be implemented according to the project presented. This mitigation measure would reduce the risk of physical harm, but it would not reduce the spatial extent of the impact of radiated noise in the habitat. In addition, its implementation is compromised due to unfavourable visibility conditions (fog, waves, blinding light), resulting in work stoppage.

Question 4

Is the project, as proposed, likely to cause disturbance for the beluga? If so, what additional mitigation measures would make the disturbance acceptable? What if operations do not occur in a confined environment?

Response 4

Since belugas are very sensitive to noise and respond quickly to changing noise conditions in their environment (Cosens and Dueck, 1988; 1993; Erbe and Farmer, 1998; Finley et al., 1990; Finneran et al., 2002; Lesage et al., 1999; Richardson et al., 1995; Scheifele et al. 2005), the introduction of new noise sources in the habitats they frequent regularly is likely to cause some disturbance, especially when the work must be carried out over an extended period, as with this project (20 months).

Since the region is a hub for exchanges between the Gulf of St. Lawrence and the regular frequentation sites located further upstream in the fjord, and an area where belugas occur intensively (50% of the time) for feeding, the introduction of new noise in this region which is already strongly affected by other anthropogenic sources may diminish the quality of this habitat area. Eventually, this damage could reach the point where, unable to adequately perform their vital functions, belugas would desert the sector, thus eliminating a new portion of their habitat that has already been diminished, and consequently limiting their available resources used for their recovery. In the event that they would maintain in the region, their exposure to noise may increase as well as the consequences on their health.

The proposed noise mitigation measures, when applied with care, minimize these risks, both for introduced noise levels and for the extent of their propagation in the environment. If they were not applied, but replaced by an exclusion zone, the noise emitted would be irradiated over a larger area, and would be detected at greater distances by animals, thus increasing the risk of impacts.

In the additional measures to consider in order to minimize impacts, the response to Question two should be noted, which focuses on concentrating noise at times when noise levels are already at a peak, in order to conceal them as much as possible and not affect the periods when actual noise is at low levels.

There is also the possibility of focusing periods of noisy work when animals are absent at the mouth of the Saguenay, which represents 50% of the time according to the multiyear observations by the SSLMP in Pointe-Noire (Conversano, unpublished data; SSLMP, unpublished data). As animals access the area either downstream, in the estuary, or upstream, in the fjord, monitoring the arrival of animals at these junctions could help determine when to stop the loud work when animals are frequenting the area. As reported earlier, frequentation can reach high levels during special events attracting more individuals and species at the mouth of the Saguenay. Loud work should be stopped in these cases so as not to obstruct the free access to the region for the duration of the said event.

The proponent should monitor underwater noise in order to document the noise levels generated and the effectiveness of the mitigation measures, and if necessary, the degree of reaction of belugas and other marine mammals. The monitoring could be done using an autonomous acoustic hydrophone system anchored at a few distance points from the work in the mouth of the Saguenay, based on the usual deployment methods (e.g. Simard et Roy, 2008; Simard et al., 2010). Monitoring of beluga occurrence in the sector based on scientifically valid protocols should also be carried out over the duration of the work and a few weeks after completion.

Question 5

In the event the project causes disturbance to the beluga despite the implementation of additional mitigation measures, is the anticipated disturbance likely to jeopardize the species' recovery?

Response 5

As mentioned above, the beluga is sensitive to this type of noise disturbance, its habitat is already reduced in the St. Lawrence River, the area affected by the project is heavily frequented by groups made up of adults, juveniles and calves, it serves as a hub for access to other areas and is located in the heart of SSLMP committed to its protection. Disturbance by the temporary or permanent displacement of animals is likely to adversely affect the potential for recovery of this population at risk, where the loss of only a few animals can make the difference between extinction and long-term survival (Hammill et al., 2007). With the implementation of the mitigation measures proposed by the project and those discussed above, the risk of impact will be minimized. These conclusions are valid only in the context where the proposed work methods are not altered; i.e. no piling or sheet pile driving or rock excavation operations using explosives are conducted. Should this be the case, impacts on belugas and on their capacity to recover could become far more significant.

Conclusion

The proposed reconstruction project of the Tadoussac and Baie-Sainte-Catherine landing docks will occur at the heart of the beluga habitat in the St. Lawrence and Saguenay-St Lawrence Marine Park. Belugas are present there 50% of the time, at least from May to September, to feed or to transit to other frequently attended areas. Minke whales occur there frequently while other marine mammals are present more occasionally.

This area is subject to a high level of anthropogenic noise from ferries and from the ecotourism whale-watching fleet. Construction noise associated with the project will be an additional contribution during the construction period, estimated at 20 months. No loud noise such as impulse noise is scheduled in the project, but noise from non-impulse drilling and other operations will be frequent. The levels and frequencies of these sounds are detectable by marine mammals and fish in the region. Although the risk of causing physical damage to the animals' internal tissues is low, the noise poses a risk to the health and recovery of the St. Lawrence beluga, a species at risk and a threatened species as assessed by the COSEWIC. Should it become necessary to resort to pile driving, the risk of physical harm and negative effects on the recovery of beluga would then increase.

The noise risk impact stems from the ability of belugas to perceive the noise, the noise spreading in the environment used by the animals and the propensity of the beluga to respond to new sources of noise in its environment, which could eventually lead to a temporary or permanent abandonment of that part of their habitat.

Mitigation measures using noise attenuators, tested elsewhere, and whose effectiveness has been demonstrated, are proposed by the proponent to minimize the level and extent of noise. Alternating zones of 600 or 300 m around the work area are proposed, where the presence of a marine mammal would entail the immediate cessation of work. As the latter option does not affect the propagation of noise in the environment and its detectability at great distances from the source, and is not valid in poor visibility conditions, the first option is preferred. Additional possibilities to reduce the risk of impact are suggested, such as noise confinement to peak periods of noise present during ferry crossings and preserving the low noise periods while vessels are docked or overnight, or confinement to periods when there are no marine mammals at the mouth of the Saguenay River (50% of the time) based on visual monitoring implemented in the areas. It is also recommended not to carry out loud work during special frequentation events at the mouth of the Saguenay, due to temporary special phenomena, as previously observed in this region.

The proponent should monitor the noise that the work will produce and the propagation distance in the environment during the construction period. The mitigation measures should also include verifying their proper functioning and the monitoring of their effectiveness and the impacts during the construction period and thereafter to ensure the restoration of the initial frequentation conditions (cf. Jefferson et al., 2009).

The recommended construction operations, the proposed impact mitigation measures by the proponent and the additional measures proposed herewith should help minimize the effects of this work on the beluga and other marine mammals at the mouth of the Saguenay River. However, as noted above, this project's risk of the effects, even if minimized, are not nil. Monitoring the noise generated and the frequentation of the area by belugas will be particularly important in the present context since construction work related to coastal infrastructures will also take place in two other preferred beluga habitats during the same period, at Les Escoumins and Cacouna. The cumulative effects of the anticipated and simultaneous decrease in the quality of these three preferred beluga habitats have raised some concern. This justifies the use of strict impact mitigation measures and sustained monitoring of their effectiveness and the frequentation of these particular habitats by belugas.

Contributors

The following persons reviewed the report:

Mike Hammill	Regional Science branch, Mont-Joli
Véronique Lesage	Regional Science branch, Mont-Joli
Yvan Simard	Regional Science branch, Mont-Joli
Charley Cyr	Regional Science branch, Mont-Joli (editor)

Approved by

Serge Gosselin
Manager
Science advice, information and support branch
Maurice Lamontagne Institute, Mont-Joli, Quebec

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Maurice Lamontagne Institute
P.O. Box 1000, Mont-Joli
Quebec (Canada)
G5H 3Z4

Telephone: 418-775-0825
Fax: 418-775-0679
E-Mail: Bras@dfo-mpo.gc.ca
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